The Jupiter Laser Facility

Jim Bonlie

JLF Operations Manager

Laser Safety Officer Workshop 2014

August 19-21, 2014

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Jupiter is a multi-platform intermediate-scale facility for HED science

Mission

- Expand the frontiers of high energy-density laboratory science
- Support high energy-density science at LLNL in multiple programs
- Support, collaborate with, and expand the broader HED physics community
- Help train and recruit future scientific workforce

Approach

- Office-of-Science-style user facility at which laser time is provided free-of charge and apportioned through an open, competitive peer-review process
- Provide significantly more laboratory user access and greater flexibility than large-scale laser facilities
- Provide a variety of platforms capable of front-rank HED science for different classes of experiments
- Provide the infrastructure to safely support multiple users with a range of experience levels
- Fill an important gap between university-scale and programmatic-scale facilities

A brief history of the Facility

Early days:

- **Building dates to 1957: Rover and Pluto rocket projects.**
- **Janus started as a one-beam laser (1974) and two-Beam (1975) ICF Laser**
- **Physics directorate "leased" from the Y-Program (Lasers) starting ~1988**
- **Reconfigured with some Shiva parts (briefly called Phoenix) 1989**

Early laser system milestones credited to the Physics Directorate:

- **USP: 10 TW ultrashort pulse laser (now called Europa) 1995**
- **COMET: tabletop x-ray laser demonstrated 1997**
- **JanUSP: 100 TW -> 10^{21} W/cm^2 (now called Callisto) 1999**

Institutional investments :

- **Phase I upgrade: 1 kJ x 2, TA1 upgrades 2000 - 2003**
- **Phase II upgrade: Titan petawatt class & LP upgrades 2003 - 2005**

Jupiter Laser Facility

Expanding High Energy-Density Science

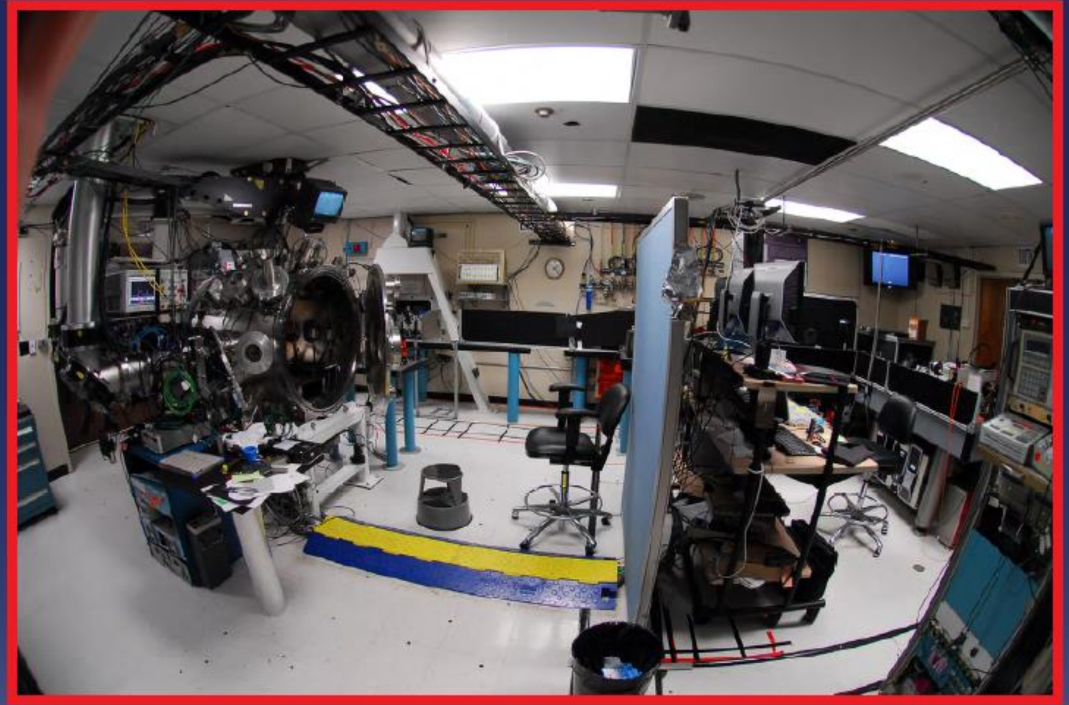
Jupiter Laser Facility

Janus Laser

Two independent long-pulse (ns) 1-kJ beams

Both East and West beams have the following capabilities		
λ	1053 nm	527 nm
Pulse	0.35-20 ns	0.35-20 ns
Energy	Up to 1 kJ	Up to 500 J
Best Focus/ Phase Plates	20 μm/ 200-1000 μm	20 μm/ 200-1000 μm
Rep Rate	2/hr	2/hr

- Short-pulse 50-mJ probe available
- Beam synch continuously variable; 50 ps jitter
- VISAR and SOP are permanent diagnostics



Target chamber accepts multiple beam positions

Jupiter Laser Facility

Titan Laser

Combined long-pulse 1-kJ and short-pulse PW-class beams

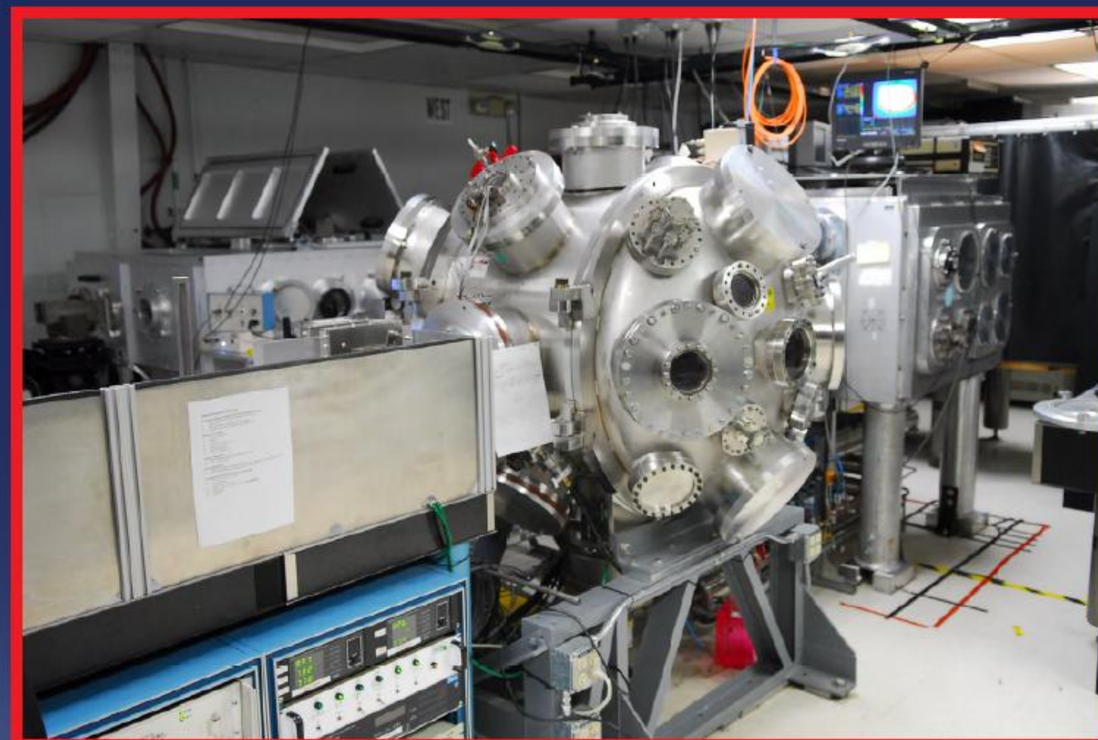
	Long-Pulse Beam		Short-Pulse Beam	
λ	1053 nm	527 nm	1053 nm	527 nm
Pulse	0.35-20 ns	0.35-20 ns	0.7-200 ps	0.7-200 ps
Energy	Up to 1 kJ	Up to 500 J	Up to 300 J	Up to 50 J
Best Focus/ Phase Plates	20 μm/ 200-1000 μm	20 μm/ 200-1000 μm	8 μm	8 μm
Rep Rate	2/hr	2/hr	2/hr	2/hr

Jupiter Laser Facility

Callisto Laser

Sub-100-fs laser capable of 200 TW in single-shot mode

Capabilities		
Mode	High Rep	Single-Shot
λ	800 nm	800 nm
Pulse	60 fs	60 fs
Energy	120 mJ	12 J
Best Focus	5 µm	5 µm
Rep Rate	10 Hz	2/hr
– 5-mJ, 60-fs probe available		



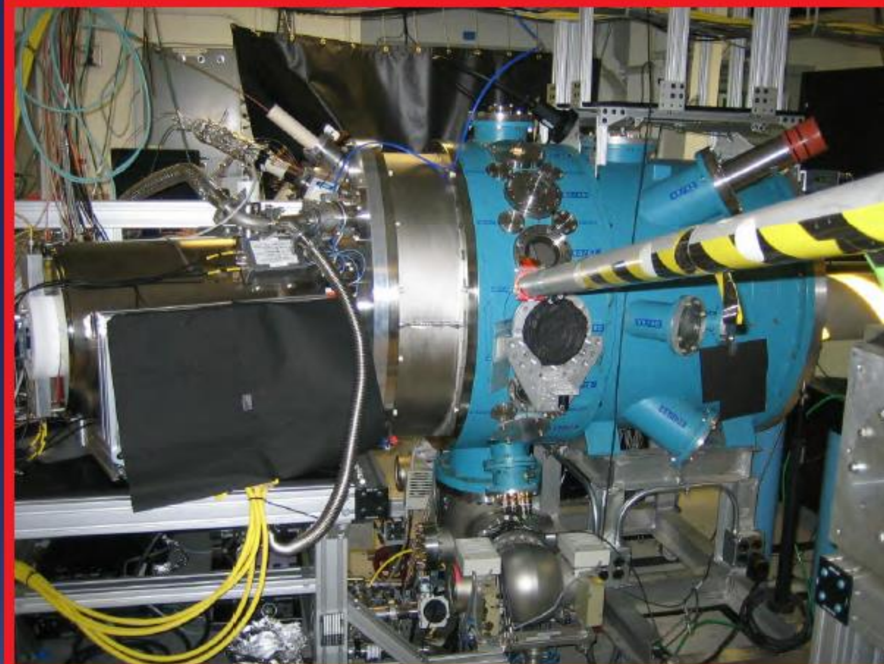
Two available target chambers

Jupiter Laser Facility
COMET Laser

COmpact MultipulsE Terawatt - a versatile multibeam system

Capabilities			
Beam #	1	2	5
λ	1053/527 nm	1053/527 nm	1053/527 nm
Pulse	0.5-260 ps	750 ps	0.5-6 ns
Energy	15/8 J	10/20 J	20/10 J
Best Focus	7×10 μm	2× Diff Limit	2× Diff Limit
Rep Rate	15/hr	15/hr	15/hr

- Two additional long-pulse/short-pulse lines (Beams 3 and 4) available
- Beams 1-4 can be operated simultaneously



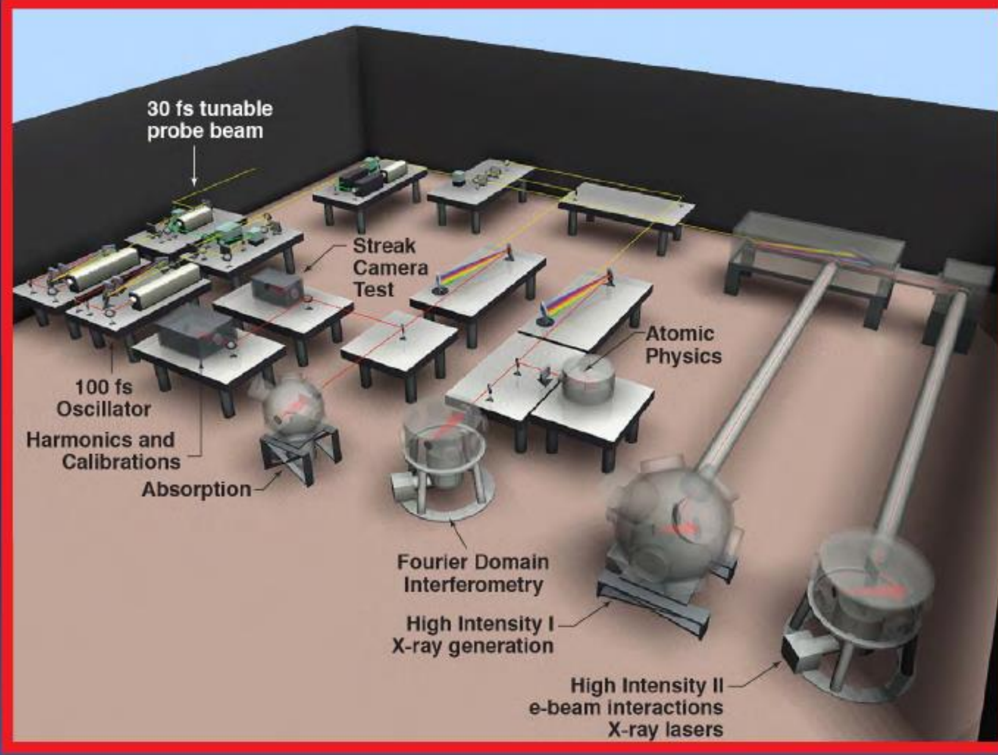
COMET can operate several beams concurrently with a 4-minute cycle time between shots

Jupiter Laser Facility

Europa Laser

20-mJ 120-fs, 10-Hz Ti:Sapphire system

Capabilities		
λ	800 nm	400 nm
Pulse	120 fs	100 fs
Energy	20 mJ	6 mJ
Best Focus	3× Diff Limit	3× Diff Limit
Rep Rate	10 Hz	10 Hz
– Pulses can be multiplexed – Multiple target chambers		



Europa is a well-equipped system especially suitable for configuration tests and training

Significant events in the past 10 years

Transitioned to a LLNL user facility 2003 – 2005 (post Phase I upgrades):

- **Beam time divided between LLNL Directorate programs for:**
  - **Stockpile Stewardship**
  - **Material sciences**
  - **Fusion research**
  - **High energy-density plasma physics**
- **While Phase II (Titan) was being built out**

2005 - 2008 Jupiter was operated as a user facility – 44 weeks a year:

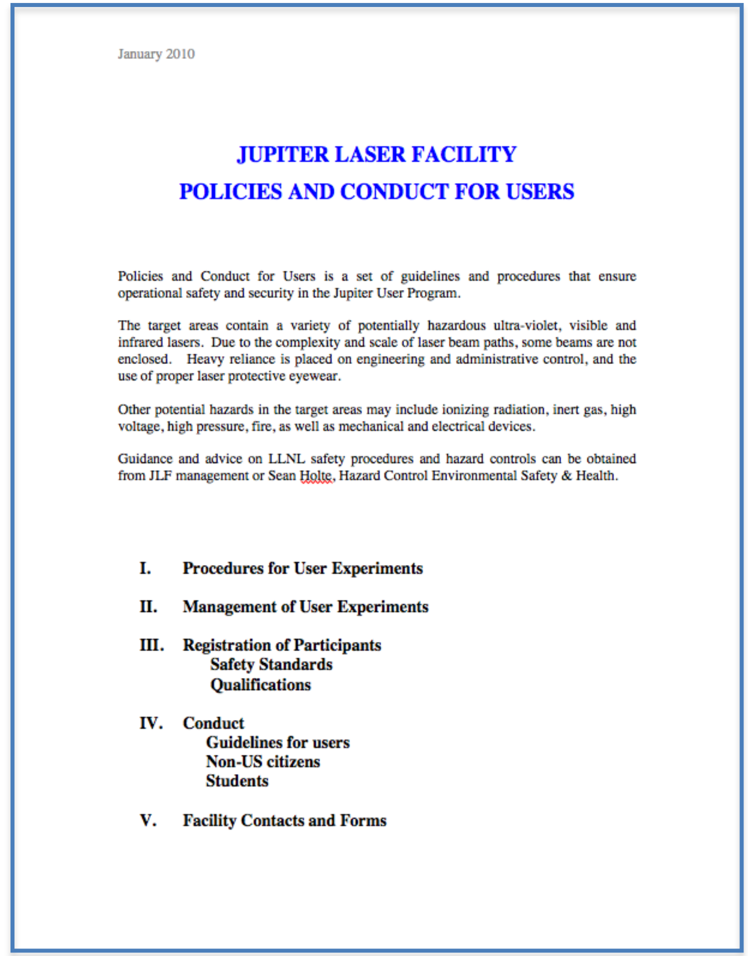
- **2005 Re-naming of facility and platforms**
- **2006 Became a Strategic Mission Support Facility – Aurora Initiative**
- **Ever increasing university and international laboratory collaborations**

Since 2008 – An open international competition for JLF experiment access:

- **The facility has always been provided free of charge to users**
- **Infrastructure to handle multiple users with different experience levels**
- **JLF is thought by some to be a proof of principle user facility**

JLF has the infrastructure to handle many and varied users who perform experiments

- Facility time allocated based on proposals presented to a technical review committee
  - based on scientific merit, impact, and feasibility
- Users must be formally registered by the JLF
  - laser eye exam, safety courses, policy briefing, safety briefings & orientations
- Special provisions for students
  - line-of-sight supervision; work unsupervised with 3 months' experience and a petition to JLF staff
- Lead experimentalists must be experienced
- Work performed under LLNL ES&H Manual regs using Integrated Safety Management processes (IWSs, Work Control, operational procedures, close contact with Safety Team members)
- Experiments reviewed for readiness and teams are debriefed on interactions



January 2010

JUPITER LASER FACILITY

POLICIES AND CONDUCT FOR USERS

Policies and Conduct for Users is a set of guidelines and procedures that ensure operational safety and security in the Jupiter User Program.

The target areas contain a variety of potentially hazardous ultra-violet, visible and infrared lasers. Due to the complexity and scale of laser beam paths, some beams are not enclosed. Heavy reliance is placed on engineering and administrative control, and the use of proper laser protective eyewear.

Other potential hazards in the target areas may include ionizing radiation, inert gas, high voltage, high pressure, fire, as well as mechanical and electrical devices.

Guidance and advice on LLNL safety procedures and hazard controls can be obtained from JLF management or Sean Holte, Hazard Control Environmental Safety & Health.

I. Procedures for User Experiments

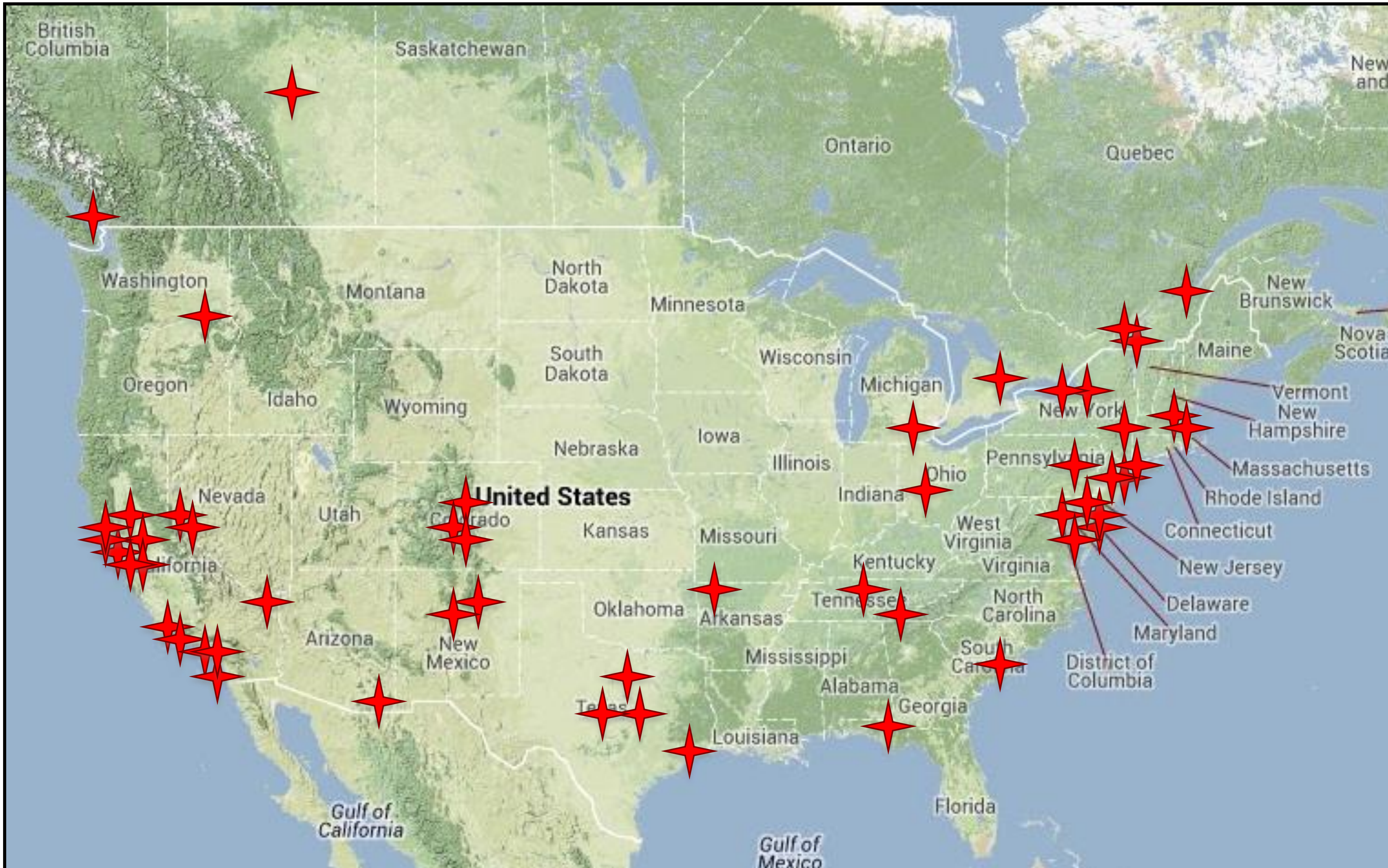
II. Management of User Experiments

III. Registration of Participants
Safety Standards
Qualifications

IV. Conduct
Guidelines for users
Non-US citizens
Students

V. Facility Contacts and Forms

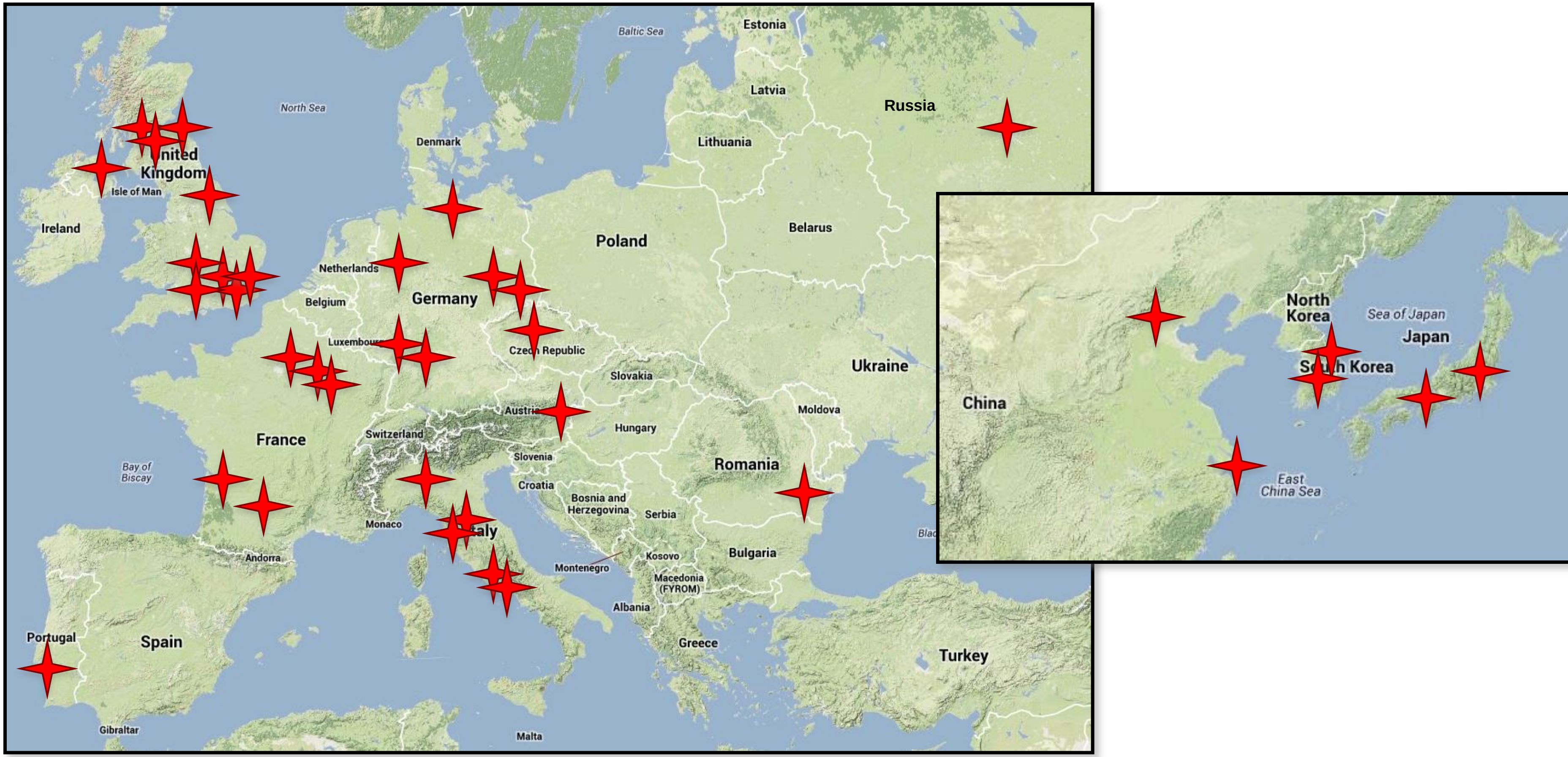
Jupiter users come from academic institutions and laboratories in the US and Canada,



ENGINEERING

Physical and Life SCIENCES

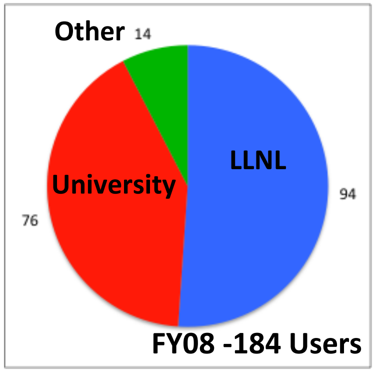
as well as in Europe and Asia

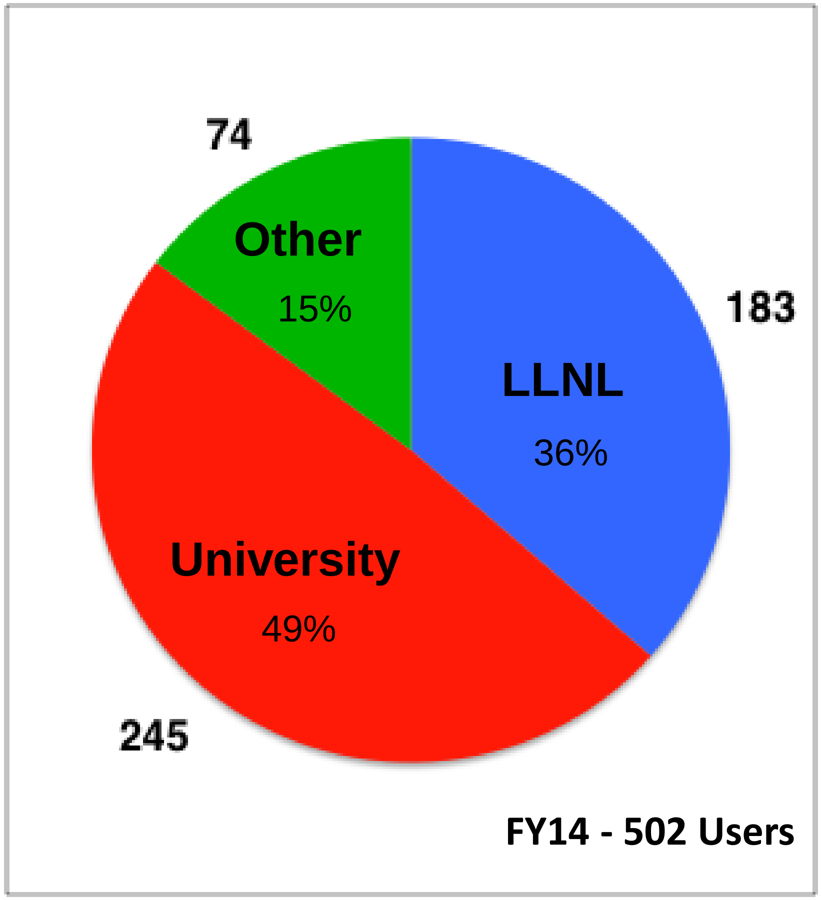


ENGINEERING

Physical and Life SCIENCES

Number of active JLF users has significantly increased since becoming an open user facility





A number of institutions and organizations involved in HED science have active JLF users

LLNL

Engineering
NIF
PLS
WCI

Colorado St
Columbia
Florida A&M
Harvard
MIT
Merchant Marine Acad
Ohio State
Princeton
Rice
South Carolina State
Stanford
Texas A&M
U Arizona
U Arkansas
UC-Berkeley
UC-Davis
UCLA
UC-San Diego
UC-Santa Barbara
U Colorado
U Maryland
U Michigan
U Nevada Las Vegas
U Nevada Reno
U Pennsylvania
U Rochester
U South
U Texas
Vanderbilt
Washington State
West Point

Academy Science Czech
Chinese Academy of Sciences
Ecole Polytechnique
Gwangju IST
Heinrich-Heine U
Imperial College
INRS - Montreal
IST Lisbon
McGill U
Nat Inst Nucl Phys Italy
Osaka U
Queen's U Belfast
Russian Academy of Sciences
Shanghai Jiao Tong U
Tech U Darmstadt
Tech U Dresden
U Alberta
U Bordeaux/CELIA
U British Columbia
U Edinburgh
U Glasgow
U Jena
U Milano
U Oxford
U Paris
U Pisa
U Quebec
U Rome
U Strathclyde
U Toronto
U York
Vienna U Tech

Other Institutions

ARFL
Carnegie Inst
DTRA
Ecopulse
EMC
GA
LANL
LBNL
LLE
NIST
NRL
NSTec
NTF
SLAC

AWE
CEA
CNR/Pisa
DESY
GSI
LNCMI Toulouse
JAEA Japan
KAERI Korea
Kentech
RAL
Rom Inst Phys & NE

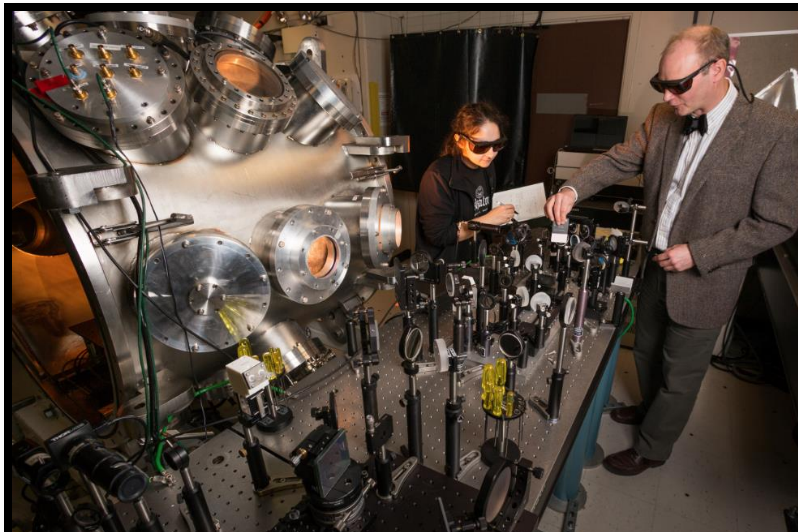
Most PhD students stay in the HED community; many stay at LLNL

PhD Student	School	Grad Year	Employment
Matthew Allen	UC – Berkeley	2004	Staff Sandia/ABQ; 2007 intern House DHS Committee
Tommy Ao	U British Columbia	2004	Staff Sandia/ABQ
Jim King	UC – Davis	2006	Ohio State, sited at LLNL
Kramer Akli	UC – Davis	2006	Staff GA; 2010 Ohio State U
Gillis Dyer	U Texas – Austin	2007	Staff U Texas - Austin
Jorge Filevich	Colorado State	2007	Postdoc Colorado State; 2010 Industry
Alessandra Ravasio	Ecole Polytechnique	2007	Research staff CNRS
Dan Hey	UC – Davis	2007	Postdoc LLNL/NIF; 2010 Industry
Dustin Offerman	Ohio State U	2008	Postdoc LANL; 2012 consultant
Andrew Higgenbotham	Oxford	2009	Lecturer Oxford
Despina Milathianaki	U Texas – Austin	2009	Postdoc LLNL; 2011 Staff SLAC
Benjamin Barbrel	Ecole Polytechnique	2009	Staff CEA, sited at SLAC
Stewart McWilliams	UC – Berkeley	2009	Staff Carnegie Inst Washington
Sophia Chen	UC – San Diego	2009	Postdoc LLNL/PLS; 2011 NSF Postdoc
Cliff Chen	MIT	2009	Postdoc LLNL/PLS
Andrea Kritcher	UC – Berkeley	2009	Lawrence Fellow, 2012, Staff LLNL/NIF
Joe Ralph	UC – Los Angeles	2009	Staff LLNL/NIF
Tammy Ma	UC – San Diego	2010	Postdoc LLNL/NIF
Steven Ross	UC - San Diego	2010	Postdoc LLNL/NIF
Art Pak	UC – Los Angeles	2010	Postdoc LLNL/NIF
Nathan Kugland	UC – Los Angeles	2010	Postdoc LLNL/NIF; 2013 industry
Tony Link	Ohio State U	2010	Postdoc LLNL/PLS
Dylan Spaulding	UC - Berkeley	2010	Postdoc CEA; 2012 Postdoc Harvard
Tyan-lin Wang	UC – Los Angeles	2010	Industry
Andrew Collette	UC – Los Angeles	2010	Postdoc U Colorado
Frederic Perez	Ecole Polytechnique	2011	Postdoc LLNL/PLS
Erik Shipton	UC - San Diego	2011	Staff General Atomics
Alexander Pelka	Tech U Darmstadt	2011	Postdoc Ecole Polytechnique
Ana Manic	Ecole Polytechnique	2011	Asst Professor U Nis, Serbia
Teresa Bartel	UC - San Diego	2011	Industry
Alex James	UC - San Diego	2011	Postdoc Princeton
Brad Pollock	UC - San Diego	2012	Lawrence Fellow LLNL/NIF
Drew Higginson	UC - San Diego	2012	Postdoc Ecole Polytechnique
Toshinori Yabuuchi	UC - San Diego	2012	Asst Professor Osaka U
Paul Davis	UC - Berkeley	2012	Postdoc UC Berkeley; FY14 Congressional Fellow
Matthew Suggit	Oxford	2012	Postdoc Oxford
Kelly Cone	UC - Davis	2012	Industry
Katerina Falk	Oxford	2012	Postdoc LANL
Richard Kraus	Harvard	2013	Lawrence Fellow LLNL/PLS
Maxence Gauthier	Ecole Polytechnique	2013	Postdoc offer LLNL
Emma McBride	U Edinburgh	2013	Postdoc DESY
Andrew Krygier	Ohio State U	2013	Postdoc Ohio State
Ian Bush	U York	2013	Postdoc Imperial College London
David Turnbull	Princeton	2013	Postdoc LLNL/NIF
Elijah Kemp	Ohio State U	2013	Postdoc LLNL/PLS
Dominik Kraus	TU Darmstadt	2013	Postdoc UC Berkeley
Franklin Dollar	U Michigan	2013	Postdoc U Col/JILA
Amadou Nourou	Ecole Polytechnique	2013	Lecturer U Abdou Moumouni, Niger
Sam Feldman	U Texas – Austin	2013	Industry
Brad Westover	UC - San Diego	2013	Finishing
Lee Elberson	U Maryland	2013	Finishing

- **FY12: 95 student users of JLF**
- **FY13: 117 student users of JLF**
- **FY14: 130 student users of JLF**

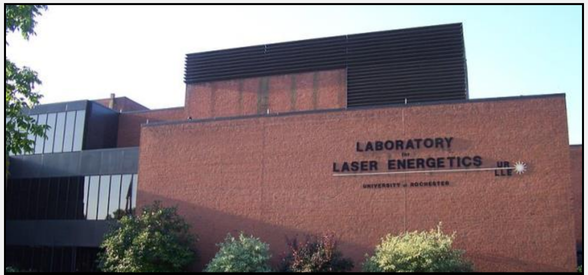
- **49 PhD's since 2009**
  - **18 became postdocs at LLNL including 3 Lawrence Fellows**

- **2 more finishing**



Jupiter is a development and proving ground for experiments and diagnostics that stage to larger facilities

Chen (LLNL) – Positron Jets (Titan)
Wark (Oxford) – Dynamic Deformation (Janus)
Koenig (LULI) – WDM EOS (Titan)
Multiple Users – Fast Ignition Studies, High-Pressure EOS, Thomson Scattering, X-ray Source Development, Detector Development



Laboratory for Laser Energetics

Chen (LLNL) – Pair Plasmas (Titan)
Gregori (Oxford) – Collisionless Shocks (Titan)
Falcone (UCB) – Thomson Scattering (Titan, Janus)
Collins Group (LLNL) – Planetary Science, EOS (Janus)
Lowry/Baker (LLNL) – Ultrafast Detectors (Callisto)
NIF/NSTec/GA – X-ray Detector Qualification (COMET)


NIF

Hoarty (AWE) – High-Temperature Opacity/EOS (Titan)


ORION (AWE)

Jupiter has produced 122 peer-reviewed publications since 2008

nature COMMUNICATIONS

ARTICLE

Received 10 Jul 2012 | Accepted 23 Oct 2012 | Published xx xxx 2012 DOI: 10.1038/ncomms2225

Nanosecond white-light Laue diffraction measurements of dislocation microstructure in shock-compressed single-crystal copper

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JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 117, E09009, doi:10.1029/2012JE004082, 2012

Shock vaporization of silica and the thermodynamics of planetary impact events

R. G. Kraus,[1] S. T. Stewart,[1] D. C. Swift,[2] C. A. Bolme,[3] R. F. Smith,[2] S. Hamel,[2] B. D. Hammel,[2] D. K. Spaulding,[4] D. G. Hicks,[2] J. H. Eggert,[2] and G. W. Collins[2]

Received 15 March 2012; revised 17 August 2012; accepted 18 August 2012; published 28 September 2012.

[1] The most energetic planetary collisions attain shock pressures that result in abundant melting and vaporization. Accurate predictions of the extent of melting and vaporization require knowledge of vast regions of the phase diagrams of the constituent materials. To reach the liquid-vapor phase boundary of silica, we conducted uniaxial shock-and-release experiments, where quartz was shocked to a state sufficient to initiate vaporization upon isentropic decompression (hundreds of GPa). The apparent temperature of the decompressing fluid was measured with a streaked optical pyrometer, and the bulk density was inferred by stagnation onto a standard window. To interpret the observed post-shock temperatures, we developed a model for the apparent temperature of a material isentropically decompressing through the liquid-vapor coexistence region. Using published thermodynamic data, we revised the liquid-vapor boundary for silica and calculated the entropy on the quartz Hugoniot. The silica post-shock temperature measurements, up to entropies beyond the critical point, are in excellent qualitative agreement with the predictions from the decompressing two-phase mixture model. Shock-and-release experiments provide an accurate measurement of the temperature on the phase boundary for entropies below the critical point, with increasing uncertainties near and above the critical point entropy. Our new criteria for shock-induced vaporization of quartz are much lower than previous estimates, primarily because of the revised entropy on the Hugoniot. As the thermodynamics of other silicates are expected to be similar to quartz, vaporization is a significant process during high-velocity planetary collisions.

Citation: Kraus, R. G., et al. (2012), Shock vaporization of silica and the thermodynamics of planetary impact events, J. Geophys. Res., 117, E09009, doi:10.1029/2012JE004082.

PRL 109, 145006 (2012) PHYSICAL REVIEW LETTERS week ending 5 OCTOBER 2012

Dynamics of Relativistic Laser-Plasma Interaction on Solid Targets

Y. Ping,[1] A. J. Kemp,[1] L. Divol,[1] M. H. Key,[1] P. K. Patel,[1] K. U. Akli,[2] F. N. Beg,[3] S. Chawla,[3] C. D. Chen,[1] R. R. Freeman,[4] D. Hey,[1] D. P. Higginson,[3] L. C. Jarrott,[3] G. E. Kemp,[4] A. Link,[4] H. S. McLean,[1] H. Sawada,[3] R. B. Stephens,[2] D. Turnbull,[5] B. Westover,[3] and S. C. Wilks[1]
[1]Lawrence Livermore National Laboratory, Livermore, California 94550, USA
[2]General Atomics, San Diego, California 92186, USA
[3]Department of Mechanical and Aerospace Engineering, University of California-San Diego, La Jolla, California 92093, USA
[4]College of Mathematical and Physical Sciences, Ohio State University, Columbus, Ohio 43210, USA
[5]Department of Mechanical and Aerospace Engineering, Princeton University, Princeton, New Jersey 08544, USA

(Received 6 May 2011; published 5 October 2012)

A novel time-resolved diagnostic is used to record the critical surface motion during picosecond-scale relativistic laser interaction with a solid target. Single-shot measurements of the specular light show a redshift decreasing with time during the interaction, corresponding to a slowing-down of the hole boring process into overdense plasma. On-shot full characterization of the laser pulse enables simulations of the experiment without any free parameters. Two-dimensional particle-in-cell simulations yield redshifts that agree with the data, and support a simple explanation of the slowing-down of the critical surface based on momentum conservation between ions and *reflected* laser light.

DOI: 10.1103/PhysRevLett.109.145006 PACS numbers: 52.38.−r, 52.27.Ny

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High Energy Density Physics

non-equilibrium warm dense gold

Byoung-ick Cho, Phil Heimann, Eric Schwegler

J inst

the principal shock

H. E. Lorenzana,[2] and

PRL 108, 065701 (2012) PHYSICAL REVIEW LETTERS week ending 10 FEBRUARY 2012

Evidence for a Phase Transition in Silicate Melt at Extreme Pressure and Temperature Conditions

D. K. Spaulding,[1,*] R. S. McWilliams,[4] R. Jeanloz,[1,2] J. H. Eggert,[3] P. M. Celliers,[3] D. G. Hicks,[3] G. W. Collins,[3] and R. F. Smith[3]
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[3]Shock Physics Group, Lawrence Livermore National Laboratory, Livermore, California 94550, USA
[4]Geophysical Laboratory, Carnegie Institution of Washington, 5251 Broad Branch Road Northwest, Washington, D.C. 20015, USA and Howard University, 2400 Sixth Street NW, Washington, D.C. 20059, USA.

(Received 31 August 2011; published 8 February 2012)

Laser-driven shock compression experiments reveal the presence of a phase transition in $MgSiO_3$ over the pressure-temperature range 300–400 GPa and 10 000–16 000 K, with a positive Clapeyron slope and a volume change of ~6.3 (± 2.0) percent. The observations are most readily interpreted as an abrupt liquid-liquid transition in a silicate composition representative of terrestrial planetary mantles, implying potentially significant consequences for the thermal-chemical evolution of extrasolar planetary interiors. In addition, the present results extend the Hugoniot equation of state of $MgSiO_3$ single crystal and glass to 950 GPa.

DOI: 10.1103/PhysRevLett.108.065701 PACS numbers: 64.70.Ja, 62.50.−p, 64.30.Jk, 91.45.Bg

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RAPID COMMUNICATIONS

PHYSICAL REVIEW E 86, 065402(R) (2012)

laser light to fast electrons in cone-guided fast ignition

macher, M. Storm, M. Fatenejad, D. Lamb, and R. R. Freeman

State University, Columbus, Ohio 43210, USA

Astronomy & Astrophysics, University of Chicago, Chicago, Illinois 60637, USA

14 August 2012; published 28 December 2012)

re used to investigate the energy coupling efficiency of laser light to fast plasma. We present experimental and simulation results demonstrating the ctively placing the cone in a surrounding high density plasma as well as the

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Phase Transformations and Metallization of Magnesium Oxide at High Pressure and Temperature

R. Stewart McWilliams,[1,2*†] Dylan K. Spaulding,[3‡] Jon H. Eggert,[4] Peter M. Celliers,[4] Damien G. Hicks,[4] Raymond F. Smith,[4] Gilbert W. Collins,[4] Raymond Jeanloz[3,5]

Magnesium oxide (MgO) is representative of the rocky materials comprising the mantles of terrestrial

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Two-dimensional m

David J. Erskine,[1,a)]

Lawrence Livermore Nati

Institut für Kernphysik, Technische Un

Lawrence Livermo

Fachbereich Physik

Kaiserslautern, E

published online 17 July 2012

We investigated various diagnos include step-wedge filters, trans scintillating detection. While n filter that is sensitive to the en 500 keV that is clearly depart annihilation radiation. © 2012 A

An apparatus for the cha deuterium with inelastic

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E-mail: pfdavis@berkeley.edu

PRL 108, 115004 (2012) PHYSICAL REVIEW LETTERS week ending 16 MARCH 2012

Hot Electron Temperature and Coupling Efficiency Scaling with Prepulse for Cone-Guided Fast Ignition

T. Ma,[1,2] H. Sawada,[2] P. K. Patel,[1] C. D. Chen,[1] L. Divol,[1] D. P. Higginson,[1,2] A. J. Kemp,[1] M. H. Key,[1] D. J. Larson,[1] S. Le Pape,[1] A. Link,[1,3] A. G. MacPhee,[1] H. S. McLean,[1] Y. Ping,[1] R. B. Stephens,[4] S. C. Wilks,[1] and F. N. Beg[2]
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[3]The Ohio State University, Columbus, Ohio 43210, USA
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(Received 3 December 2011; published 16 March 2012)

The effect of increasing prepulse energy levels on the energy spectrum and coupling into forward-going electrons is evaluated in a cone-guided fast-ignition relevant geometry using cone-wire targets irradiated with a high intensity (10^{20} W/cm^2) laser pulse. Hot electron temperature and flux are inferred from $K\alpha$ images and yields using hybrid particle-in-cell simulations. A two-temperature distribution of hot electrons was required to fit the full profile, with the ratio of energy in a higher energy (MeV) component increasing with a larger prepulse. As prepulse energies were increased from 8 mJ to 1 J, overall coupling from laser to all hot electrons entering the wire was found to fall from 8.4% to 2.5% while coupling into only the 1–3 MeV electrons dropped from 0.57% to 0.03%.

DOI: 10.1103/PhysRevLett.108.115004 PACS numbers: 52.50.Jm, 52.38.Kd, 52.38.Mf, 52.70.La

and fusion burn-history measurements with ~ ps resolution. © 2012 American Institute of Physics. [http://dx.doi.org/10.1063/1.4729677]

PHYSICAL REVIEW B 86, 245204 (2012)

Orientation and rate dependence in high strain-rate compression of single-crystal silicon

R. F. Smith,[1] R. W. Minich,[1] R. E. Rudd,[1] J. H. Eggert,[1] C. A. Bolme,[2] S. L. Brygoo,[3] A. M. Jones,[1,*] and G. W. Collins[1]
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(Received 6 August 2012; published 17 December 2012)

High strain-rate ($\dot{\epsilon} \sim 10^6$–10^9 s^{-1}) compression of single crystal Si reveals strong orientation- and rate-dependent precursor stresses. At these high compression rates, the peak elastic stress, σ_{E_Peak}, for Si [100], [110], and [111] exceeds twice the Hugoniot elastic limit. Near the loading surface, the rate at which Si evolves from uniaxial compression to a three-dimensional relaxed state is exponentially dependent on σ_{E_Peak} and independent of initial crystal orientation. At later times, the high elastic wave speed results in a temporal decoupling of the elastic precursor from the main inelastic wave. A rapid high-$\dot{\epsilon}$ increase in the measured elastic stress at the onset of inelastic deformation is consistent with a transition from dislocation flow mediated by thermal activation to a phonon drag regime.

DOI: 10.1103/PhysRevB.86.245204 PACS number(s): 61.72.uf, 62.20.F−, 62.20.D−

Physical and Life SCIENCES

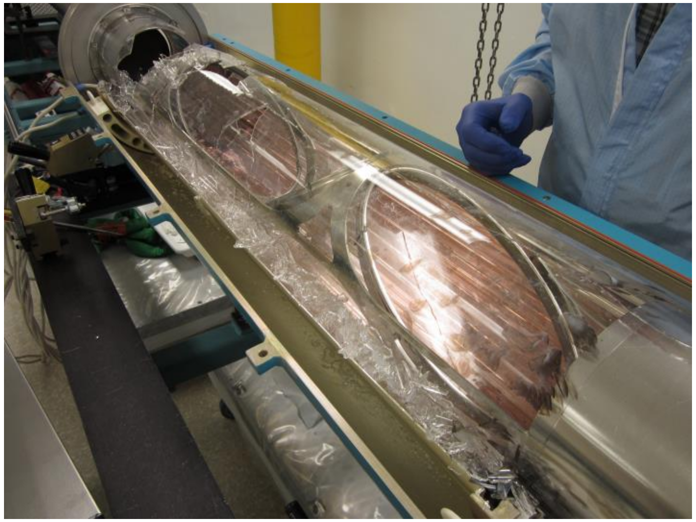
A few realities

- The number of JLF users – ~500 – is comparable to the number of LLE/OMEGA users

- JLF Technical Review committee turns down half or more of JLF proposals

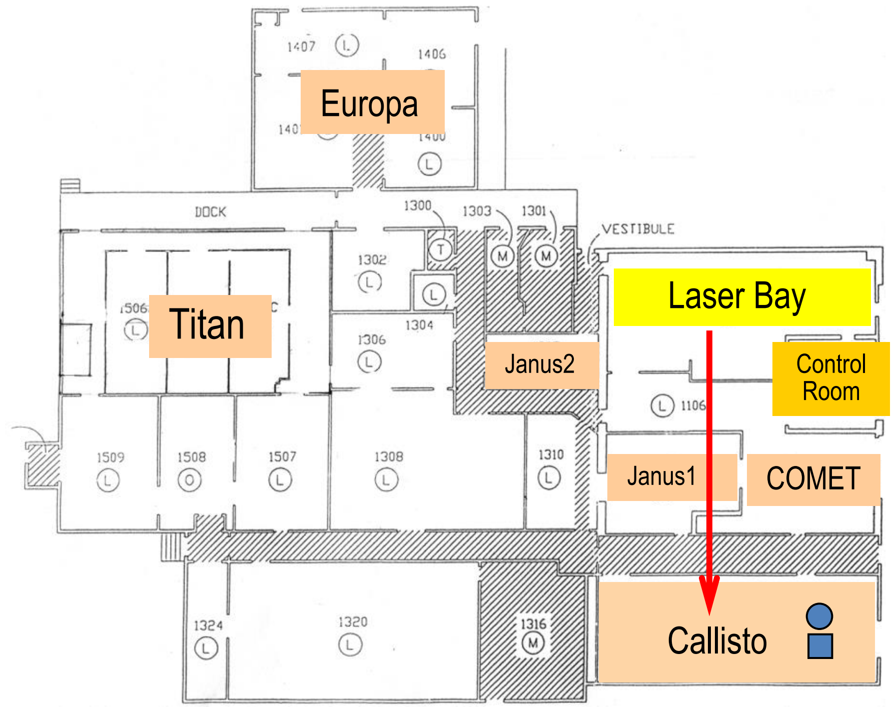
- The JLF budget has been flat or down for 6 straight years and improvement requests have not had institutional priority

- Reduced number of shot-weeks, conservatism WRT laser parameters limit damage to expensive components, consolidation of target areas



What happened on 18 December 2008?

- A high-energy (> 100 J) beam was propagated from the Laser Bay to the Callisto Target Area while personnel were in the room
- By procedure the room should have been evacuated before shot.
- Miscommunication led to the mishap
  - Shot countdown paused
  - Target Area called for restart
  - Control Room resumed countdown
  - Staff attempted to break interlock (too late)
- No one was injured; PPE was in use
- Laser energy absorbed by a diode placed in the beampath to monitor low-level beam (diode was on an enclosed optical table in the Callisto TA)
- RI was present. Work was paused. Communication was “fixed” by adding a verbal evacuation confirmation and the shooting continued.



In Callisto the 100-J beam is used to pump final amplifiers of the tabletop laser located in the room; that laser fires into a chamber.

Lessons learned

- Staff was driven by need to serve and accomplish; productivity *vs.* deliberateness was not in same balance as similar facilities: highly dedicated but too focused on results (shots); bending over backward to be flexible; lack of appropriate hardware backing up administrative controls.

- Any facility that operates and evolves over a length of time should periodically do a Full Stop. For JLF the period is about one year; the length of the Stop should be about a week. Opportunity to *reassess in depth* without the "distraction" of users or even operations, clean up. All workers participate. This is an element of the ISSM - Feedback - and is a feature of yearly JLF schedules

- Stop Work policy, in particular what to do <u>after</u> a Stop Work, should be addressed

Users are safe in the JLF

- They are trained, but JLF staff now has more oversight responsibility

Report recommendations and Action Plan responses

Overview Recommendation	Action Plan
Review JLF for Extent of Condition	✔ Even though recommendation was specific to Callisto, same conditions pertain in Laser Bay and all TAs except Europa
Review/communicate Stop Work policy	✔ Review ES&H Manual Section 2.1 with staff and with users

Hardware Recommendation	Action Plan
Install engineering controls outside Callisto	✔ Install keyed permissives (key-enable boxes) outside main door in LB and all TAs
Install sweep buttons inside Callisto	✔ Install sweep buttons on all access doors inside LB and all TAs; time-synch to key boxes
Evaluate interlock system in Callisto	✔ Modify interlock shutter so that “crowbar” time reduced from 2 seconds to 100-ms
Evaluate legacy interlocks/displays in Callisto	✔ Remove legacy interlocks/displays throughout B174
Review JLF safety interlock system	✔ Review safety interlock system; test all components
Revise recorded message system	✔ Reprogram recorded messages; synch with control system

Report recommendations and Action Plan responses

Conduct of Ops Recommendations	Action Plan
Establish formal <u>sweep</u> procedures	✔ Define, document, and communicate sweep procedures specific to LB and all TAs
Formalize <u>roles & responsibilities</u>	✔ - Mandate single-POC regarding shot sequence communications - POC is Key Holder (KH) and is responsible for sweep - Define key checkout procedure for KH - Document training
Better <u>documentation</u>	✔ - New/modified procedures incorporated in existing IWS as a document with proper change control; remove case-by-case issues by writing platform-specific IWSs and distinct cross-platform IWSs - Document OJT for CR personnel
Revise shot <u>communications</u>	✔ Shot readiness “scripts” with confirmation repeats

<u>Communications to users:</u>

- Briefings (informal) and emails (formal)
- “Read and sign” on modified IWS with new procedures
- Mandatory experimenter attendance at <u>Plan-of-the Day</u> meetings
- Mandatory <u>Readiness Review</u> meetings
- Modified new-user <u>Policy Briefing</u>

Questions?


Jupiter Laser Facility
Janus • Titan • Callisto • Europa • COMET
Jupiter Laser Facility
Supporting the broad community of High Energy Density researchers.
Physical Sciences Directorate

- **Extra slides about HED science at the JLF follow.**

Jupiter is a multi-platform facility for high energy-density (HED) science

Goal	Metric	
Broad participation by LLNL researchers	Growth in LLNL user base	Users up 200% in 4 years
Expanded HED community	Growth in non-LLNL user base and expanding diversity of user institutions	- Users up 275% in 4 years - 56 universities - 20 institutes
Front-rank HED science	Publications	- ~24 journal publications/year - ~4 PRL/Science pubs/year
Staging of expts to larger facilities	Evidence of those expts at NIF, Ω, *etc*.	XRTS, e^+ beams, ramp and Hugoniot EOS, FI, NLTE
Development of novel HED diagnostics	Implementation of diagnostics at NIF, Ω, *etc*.	2D VISAR, p+ radiography, fast detectors, x-ray sources
Training of young researchers	Growth in number of students, number of PhDs using JLF, and awards associated with JLF	- 117 student users - 2 young researcher awards - 8 PhDs per year
Pipeline into LLNL	Number of students hired by LLNL	Since 2009, 14 of 32 PhDs hired at LLNL

CY2014 experiments will investigate a number of HED areas

Janus

- Measurements of diffraction in dynamically compressed metals
- Measurement of high-pressure shear modulus of metals
- Shock-induced chemistry
- Evolution of shocks in solids
- Phase transitions in metals and geophysical materials
- Generation and amplification of magnetic fields in shocked atmospheres

Titan

- Electron beam generation and broadband x-ray source development
- Stopping power, structure factor, and conductivity measurements in warm dense matter
- MeV particle acceleration using shocks and multiple pulse techniques
- Magnetic confinement of positrons
- Hot electron generation and control
- Characterization of magnetic fields in laser plasmas